# M1 and the Price Level: The Effect Increases in M1 had on CPI in England and the United States

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**Abstract**

The effects of increases in M1 are tested on the CPI level and Inflation Rate. The data used are from FREDR, and include both the GBP and USD, M1 and CPI series. The method used is a Bi-variate VAR model. The data is trained from 01/2000-11/2023 for the UK, and 01/2000-09/2024 for the USA. We then forecast the CPI level for both economies 60 months into the future.

# 1 Introduction

Martín de Azpilcueta, a Spanish theologian and economist, observed in 1556 that the large influx of gold and silver from the New World into Spain caused a general rise in prices.[2] This laid the groundwork for the Quanity Theory of Money, which connected increases in money supply with price inflation; however this understanding existed long before Azpilcueta formally connected it. Money in the past had been backed by hard assets like gold and silver that have intrinsic value. Azpilcueta was the first economist to formally that increases in the supply of money will decrease the value of the money. Debasement had been the main issue in the past, where people began to lose faith in the value of their money. Here is now an example of how increases without debasement had increased the price level of goods.

Debasement had been a historical problem for years, as the value of a silver or gold coins can be stretched if the composition of the base metal in the coins can be cut or diluted. The Roman Empire for instance, had continuously debased its currency to afford the continuous wars of conquest. The Denarius, a high purity sliver coin in the 3rd century, became only 5% silver by the time of Emperor Gallienus (253–268 AD).[6] The debasement of currency led to hyper inflation, caused citizens to hoard higher-content older coins (Gresham's law), and hindered long distance trade.[8]

In modern times, fiat currency has become the new standard. the problem of debasing coinage is not longer an issue; however fiat currency brings its own set of challenges. Ludwig von Mises warned that money not backed by a commodity like gold can lead to inflation due to excessive money creation by central authorities.[10] This sentiment was continued by Friedrich A. Hayek who argued in 1976 for the abolition of the government monopoly over the issuance of money.[7] Some Bitcoin and cryptocurrency enthusiasts have parroting this idea, which may prevent abuses in the unchecked printing of fiat currency, and the economic turmoil that follows. Notable examples of this abuse are Zimbabwe (2000s)[5], Yugoslavia(1992-1994)[11], and Venezuela (2010's-present)[9]. These examples clearly demonstrate the detrimental effect that bad monetary and fiscal policy has on average citizens. Citizens who are powerless to the erosion of the real value of their money and income.

There are many explanations of why there was excessive inflation after the COVID-19 pandemic in 2020. The reason stem from supply chain disruption, excessive demand, and higher energy price. Former Commissioner of the Bureau of Labor Statistics (BLS) Bill Beach places the blame squarely on oh extremely high budget deficits. *Adding up the deficits for FY2020 through FY2023 totals $8.8 trillion. Outside of wartime, no four years in U.S. history has seen deficits this large, either in nominal terms or as a percent of GDP.* [1] This money rapidly increased liquidity which resulted in a spike in demand. We can see in Figure 1 that a massive increase in M1, the most liquid measure of the monetary base, coincides also with a massive jump in inflation rates.

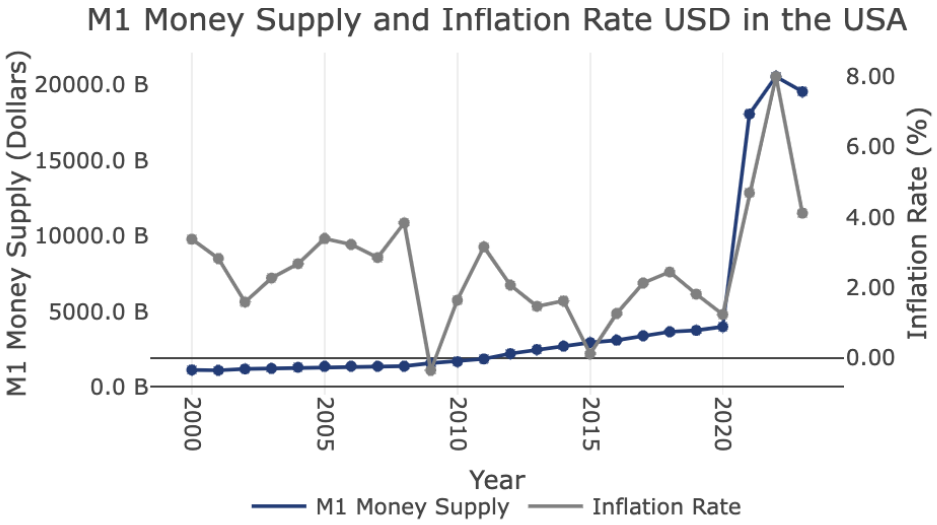


Figure 1: M1 Money Supply and the Inflation Rate

Joe Biden's Chair of the White House Council of Economic Advisers, Cecilia Rouse, stated in June 2021: "At the moment, I believe that this inflation is temporary, is transitory, as the economy works itself back together."[13] This idea of the inflation being transitory was reiterated by Treasury Sector Janet Yellen, who commented in December 2021: "I expect inflation to return to normal levels in the second half of next year."[14] Since this time the rate of inflation, A.K.A. rising prices, has dropped back to more manageable level, the issue overlooked is the new price level. M1 increases the price level (CPI) without nominal increases in income. As a result, households see their utility decline as their real wage has dropped.

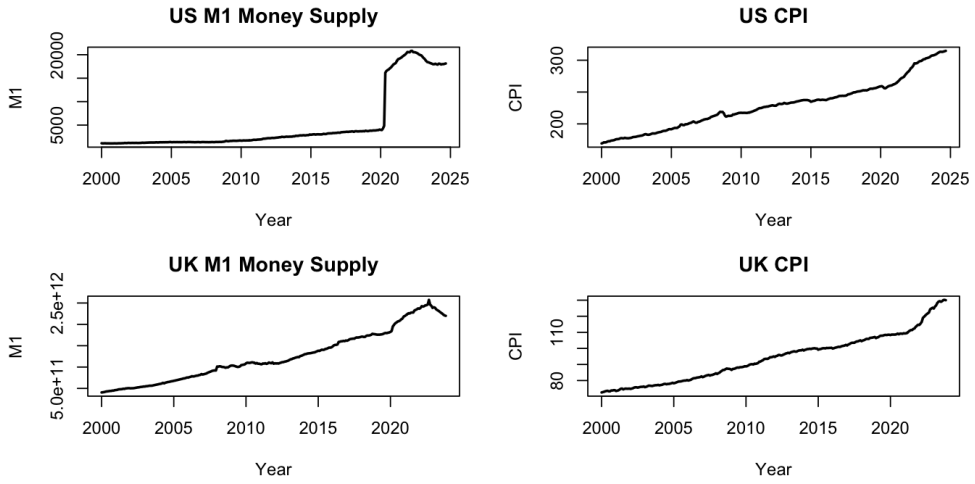


Figure 2: US/UK M1/CPI Comparison

The goal of our analysis is to predict the CPI level 5-years from the end of out training data. That is, we want to test the effect that changes in M1 have on the price level to predict how the CPI will grow over 60 periods (months). We use data for the economy of the United States and the United Kingdom's economy. By looking at Figure 2, we can see that there are differences in how quickly M1 increased in the US compared to the UK, yet their CPI levels seem to follow a similar trajectory.

# 2 Data and Methodology

The date we used came from the St. Louis Fed using the R library *fredr*. The series used were M1 aggregates for the United Kingdom[3] and the United States. We also used the series for consumer price index (CPI) for the total United Kingdom, and the CPI for all urban consumers in the United States. The reason that the CPI series do not coincide together is that the United States does not have a total CPI like the UK. This is likely because of the vast difference in size between the two economies. We then have a difference in periods, as the data is trained from 01/2000-11/2023 for the UK, and 01/2000-09/2024 for the USA. This is because fredr does not have a UK series that matched USA when we pulled the data.

In this report, we use a Vector Autoregressive (VAR) model to analyze the relationship between the money supply (M1) and the Consumer Price Index (CPI) over time. A VAR model is suitable in this context because it allows for simultaneous modeling of the interdependent time series, capturing the dynamic relationship between these economic indicators.

The VAR model of order $p$, denoted as VAR($p$), includes the past $p$ lags of both the M1 and CPI series. The general form of the VAR model with two variables $y_{1,t}$ and $y_{2,t}$ (where $y_{1,t}$ represents M1 and $y_{2,t}$ represents CPI) is as follows:

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \phi_{11,i} & \phi_{12,i} \\ \phi_{21,i} & \phi_{22,i} \end{bmatrix} \begin{bmatrix} y_{1,t-i} \\ y_{2,t-i} \end{bmatrix} + \begin{bmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \end{bmatrix} \tag{1}$$

where:

- $c_1$ and $c_2$ are the intercept terms,
- $\phi_{jk,i}$ represents the coefficient for the $i$-th lag of variable $k$ on variable $j$,
- $\epsilon_{1,t}$ and $\epsilon_{2,t}$ are the error terms for each equation, assumed to be white noise.

To select the optimal lag length $p$, we use information criteria such as the Akaike Information Criterion (AIC). By doing this, we determined the best model has a lag of 9 (see appendix for coefficients). After fitting the model, we performed a forecast of CPI based on the historical relationship with M1, analyzing forecast accuracy with confidence intervals.

### 2.1 Limitations

We are making a comparison between the United States and the United Kingdom, thus there are major differences between two. Economically, the US economy is 5-times the size of the economy of the UK. The US economy is more diverse, while the UK leans heavily on their financial services sector concentrated in London. The US is also one of the major world trading partners, while the UK has a much smaller share of world trade and is suffering some headwinds post-Brexit. Populations are also vastly different. The US has a population of 330 million and the UK has 67 million. These differences mean that their is likely other factors affecting the inflation rate in these countries. The factors that could be common between these two economies could affect each one differently.

## 3 Results

We forecasted the CPI for 60 periods (5 years) from the end of our available information. For the UK, we had up until November 2023, and we had until September 2024 for the USA. Confidence intervals are added to reflect the uncertainty in the forecast, allowing for better assessment of potential future values.

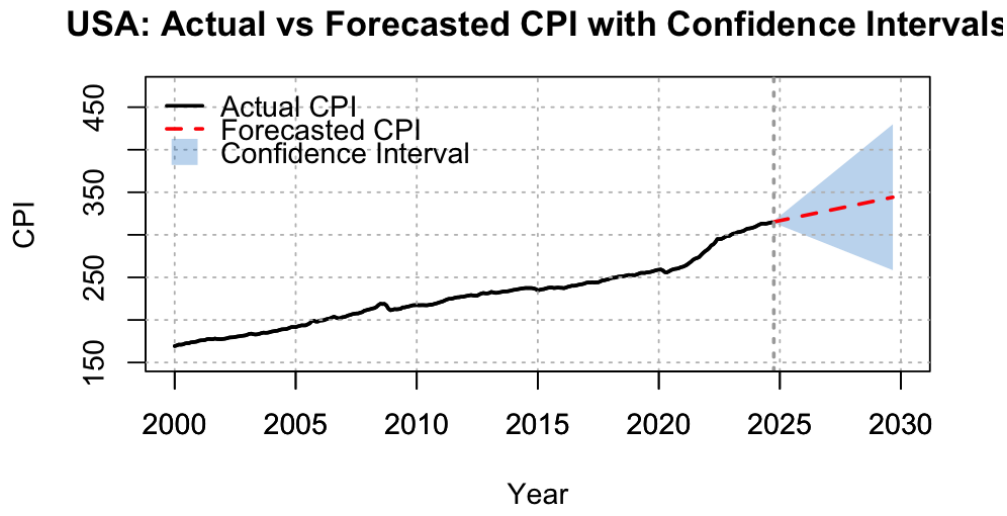


Figure 3: Forecasted US CPI after Sep. 2024

It seems our US forecast predicts the CPI to rise at an average yearly growth rate of 1.81%. This is good news, as we can be optimistic about inflation dropping. The UK CPI forecast is interesting because it shows some potential deflation. The average yearly growth rate during this period amounts to only 0.98%. After the first 2 years of deflation, with growth rates of -1.02% and -0.16%, the following 3 years begin to be a more standard 1.82%, 2.22%, and 1.70%.

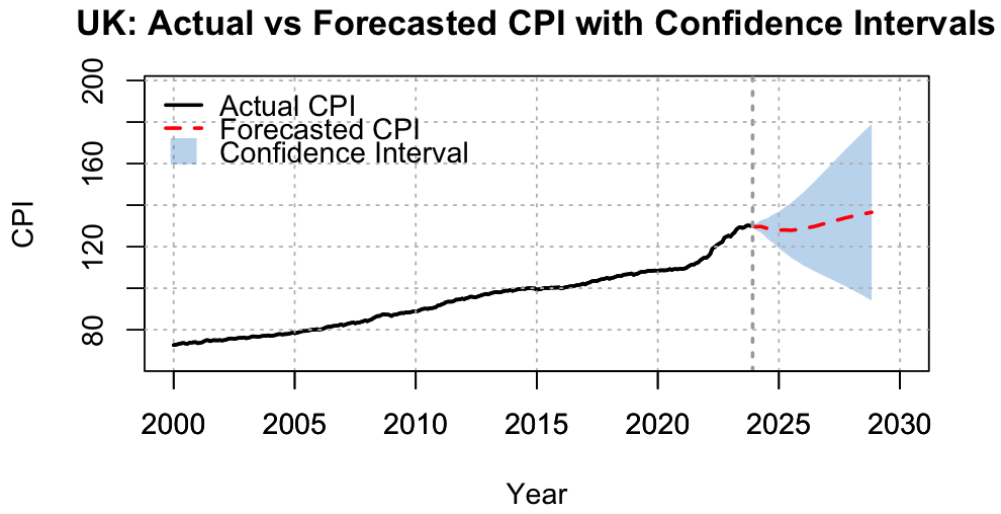


Figure 4: Forecasted UK CPI after Nov. 2023

# 4 Conclusion

Milton Friedman once stated that "Inflation is always and everywhere a monetary phenomenon."[4] Economist do attribute a lot of other things to the causes of inflation, but the most obvious and preventable by policymakers is inflation due to a drastic increase in the money supply. We can show using a simple VAR model that increases in the most liquid measure of money (M1) will increase the price level (CPI) and thus inflation. This shows that one could argue that the inflation is "transitory" yet the effects are real and will linger. The CPI level will be the new normal and will continue to rise at a steady state, likely close to the Federal Reserves target rate of 2%.

Inflation is considered a tax by many, yet it is a tax that is indirect in nature. It is considered a "hidden tax" because it erodes the purchasing power of money. It effectively transfers wealth to the government without paying a tax directly. It is insidious in a way because citizens want to avoid being overtaxed. They could refuse to pay and cause a political crisis (maybe not the best solution), but inflation is something exogenous that the average person must suffer through until prices stabilize. The hardest hit are the households dependent on salaries or fixed income. An increase in inflation is a decrease in real income. It also an erosion in the value of one's savings.

When policymakers see that the CPI is going to rise due to a rapid increase in the M!, they are not able to tell the citizens that inflation is about to take off. That would cause a massive increase in demand, as these citizens would want to make purchases prior to the price rising. So policymakers opt to say that inflation is transitory, which it is technically if you are not viewing inflation as a permanent increase in the price level. Jerome Powell the Federal Reserve Chairman, remarked in July 2021: *"In the end, inflation will be transitory because we won't allow it to be sustained."*[12]

Next steps would be to test why the inflation in the US and UK happened at different times and were different levels. It would also be interesting to check the differences in real income between the United States and the United Kingdom along with the real GDP per-capita. It would be interesting to see what drove the wealth effects of the differences in inflation levels. It would also be interesting to check other economies like the EU, Japan, China, and other individual currencies and have them in a larger model. This goes beyond the time available for this project.

# 5 Appendix

$$\mathbf{Y}_t = \mathbf{A}_1\mathbf{Y}_{t-1} + \mathbf{A}_2\mathbf{Y}_{t-2} + \cdots + \mathbf{A}_9\mathbf{Y}_{t-9} + \mathbf{C} + \mathbf{E}_t$$

## 5.1 USA VAR Coefficients

$$\mathbf{Y}_t = \begin{bmatrix} \text{m1\_diff}_t \\ \text{cpi\_diff}_t \end{bmatrix}, \quad \mathbf{A}_1 = \begin{bmatrix} -0.3543 & -11.5832 \\ -0.0009 & 0.5301 \end{bmatrix}, \quad \mathbf{A}_2 = \begin{bmatrix} -0.1889 & 4.8989 \\ -0.0001 & -0.2273 \end{bmatrix}$$

$$\mathbf{A}_3 = \begin{bmatrix} 0.2187 & -1.6440 \\ 0.0004 & -0.0609 \end{bmatrix}, \quad \mathbf{A}_4 = \begin{bmatrix} 0.2232 & 7.4090 \\ 0.0013 & 0.1298 \end{bmatrix}$$

$$\mathbf{A}_5 = \begin{bmatrix} 0.1500 & -4.4781 \\ 0.0004 & -0.1117 \end{bmatrix}, \quad \mathbf{A}_6 = \begin{bmatrix} 0.0269 & 4.8412 \\ 0.0001 & -0.0430 \end{bmatrix}$$

$$\mathbf{A}_7 = \begin{bmatrix} -0.0145 & -3.8810 \\ -0.0022 & 0.0313 \end{bmatrix}, \quad \mathbf{A}_8 = \begin{bmatrix} 0.0947 & 0.4346 \\ -0.0015 & -0.1242 \end{bmatrix}$$

$$\mathbf{A}_9 = \begin{bmatrix} 0.3053 & 6.4023 \\ -0.0012 & 0.0001 \end{bmatrix}, \quad \mathbf{C} = \begin{bmatrix} 6.7685 \\ 0.3662 \end{bmatrix}, \quad \mathbf{E}_t = \begin{bmatrix} \epsilon_{\text{m1\_diff},t} \\ \epsilon_{\text{cpi\_diff},t} \end{bmatrix}$$

## 5.2 UK VAR Coefficients

$$\mathbf{Y}_t = \begin{bmatrix} \text{m1\_diff}_t \\ \text{cpi\_diff}_t \end{bmatrix}, \quad \mathbf{A}_1 = \begin{bmatrix} 2.428 \times 10^{-12} & 0.1019 \\ 5.972 \times 10^{-13} & 0.0884 \end{bmatrix}, \quad \mathbf{A}_2 = \begin{bmatrix} 8.839 \times 10^{-15} & 0.02696 \\ -9.994 \times 10^{-13} & 0.09981 \end{bmatrix}$$

$$\mathbf{A}_3 = \begin{bmatrix} 3.550 \times 10^{-13} & 0.04208 \\ 1.984 \times 10^{-12} & 0.4656 \end{bmatrix}, \quad \mathbf{A}_4 = \begin{bmatrix} 1.599 \times 10^{-12} & 0.02668 \\ 2.496 \times 10^{-12} & 0.04777 \end{bmatrix}$$

$$\mathbf{A}_5 = \begin{bmatrix} -1.207 \times 10^{-12} & -0.133 \\ 0 & 0 \end{bmatrix}, \quad \mathbf{A}_6 = \begin{bmatrix} 1.599 \times 10^{-12} & 0.02668 \\ 2.496 \times 10^{-12} & 0.04777 \end{bmatrix}$$

$$\mathbf{A}_7 = \begin{bmatrix} 1.599 \times 10^{-12} & 0.02668 \\ 2.496 \times 10^{-12} & 0.04777 \end{bmatrix}, \quad \mathbf{A}_8 = \begin{bmatrix} 1.599 \times 10^{-12} & 0.02668 \\ 2.496 \times 10^{-12} & 0.04777 \end{bmatrix}$$

$$\mathbf{A}_9 = \begin{bmatrix} -1.207 \times 10^{-12} & -0.133 \\ 0 & 0 \end{bmatrix}, \quad \mathbf{C} = \begin{bmatrix} -0.00135 \\ 0 \end{bmatrix}, \quad \mathbf{E}_t = \begin{bmatrix} \epsilon_{\text{m1\_diff},t} \\ \epsilon_{\text{cpi\_diff},t} \end{bmatrix}$$

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